

is therefore not entirely reliable, and confirmation would be of interest.

The Black-browed Albatross was observed during two periods of the voyage, from Melbourne to Fremantle, and off the African coast. It may or may not be relevant that this species appeared when the temperature of the sea-water was below 63-64°F. and not when it was above.

Conclusion

I cannot end without expressing my gratitude to members of the Western Australian Naturalists' Club for their kindness at Perth to a passing naturalist (*Nauta exulans*, sub-species *britannicus*) and saying how much I hope some day to renew my acquaintance with them, and with my other Australian friends, both clothed and feathered.

THE CAVE FOSSILS OF THE SOUTH-WEST

By L. GLAUERT, W.A. Museum, Perth

Although over 40 years have elapsed since the first discovery, as recent cave fossils, of animals whose past presence in Western Australia had never been suggested or suspected, curiously little interest has been shown in the subject, even in scientific circles. With a view to directing further attention to the study of this highly interesting cave fauna I have prepared a brief summary of the discoveries already made, including some which have not yet been published, and include a complete list of the species of mammals so far discovered in the various caves of the South-West. As an aid to students I have also added a list of published references on the original discoveries.

The Mammoth Cave

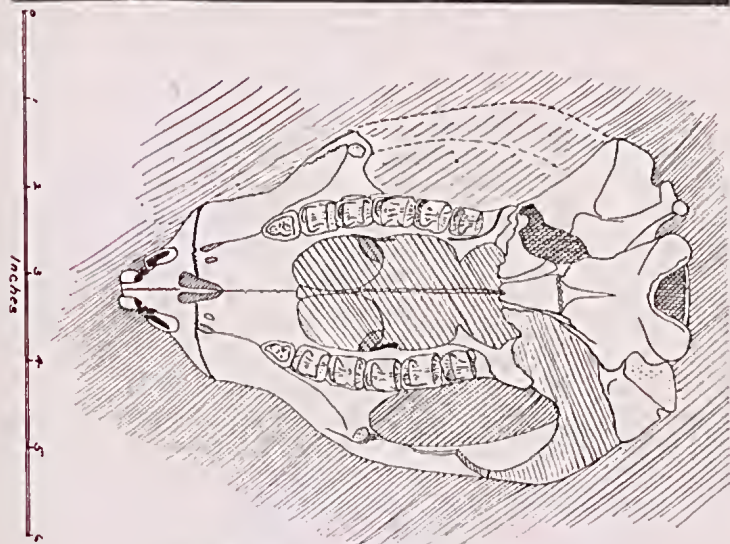
In 1904 the caretaker of the Margaret River caves, the late T. Connelly, whilst making a cutting at the top of a rock to improve a pathway, found to his surprise that the mass was not solid but that the rock was covered with bone-bearing, red cave-earth which had been protected from removal by a thick incrustation of carbonate of lime. In this earth were a number of bones and jaws with teeth which Connelly carefully preserved and subsequently handed to the late Lt.-Colonel E. A. Le Souef who brought them back to Perth.

They were subsequently handed to me for examination when it was found that they contained remains of an extinct member of the kangaroo family and of a gigantic Echidna.

In my report to the Caves Board I stated that they represented animals new to science. To the heavy-jawed Macropod I gave the name *Sthenurus occidentalis* as it was the first specimen of an animal of that genus found in Western Australia and differed in important details from the species already known from the Pleistocene deposits of eastern Australia. The giant Echidna, allied

to a form still existing in New Guinea, received the name of *Zaglossus hacketti* in honour of the chairman of the Caves Board, the Hon. Dr. J. W. Hackett, later Sir J. Winthrop Hackett.

Dr. Hackett, who was also chairman of the Museum Committee, then generously decided to finance an expedition to the cave with a view of extending the research. The results were so successful that further trips were authorised, the whole investigation extending over the period from 1909 to 1915.



Skull of *Sthenurus occidentalis*

Dorsal View

Ventral View

G. C. Clutton, photo

G. Pitt Morison del.

Several thousand bones were collected, many more or less fragmentary but including others that were of considerable scientific value. The most abundant were the long bones of the limbs; bones of the feet, which were often in perfect condition, and vertebrae. Of these the axis and caudal vertebrae were often entire whilst many of the thoracic members were reduced to centra only, the spines and processes being collected separately.

Many of them were of gigantic size and, as the only large marsupial known to occur in Western Australia was *Diprotodon optatum*, were provisionally allotted to that animal. Later however, when more bones came to light, including fragmentary maxillae and mandibles, it was evident that a mistake had been made and that the animal represented was *Nototherium mitchelli* and not a *Diprotodon*. The *Nototherium* may be described as a gigantic wombat rivalling a tapir in size. It was a herbivore whose cheek teeth were very like those of the *Diprotodon* but whose median upper incisors were tusk-like, not chisel-shaped.

Remains of *Sthenurus occidentalis* were abundant, in fact much more so than those of other large Macropoda. A large number of fragmentary maxillae and mandibles were found as well as more complete ones. An almost complete skull enables us to visualise the appearance of this remarkable member of the kangaroo family. Its shortened skull, massive jaws and thickly wrinkled molars suggest a very tough diet such as the coarser shrubs of the Pleistocene bushland.

Further surprises were provided by skulls and jaws of species still living in eastern Australia or Tasmania, such as the Wombat (*Phascolomis* sp.), the Koala (*Phascolarctos cinereus*), the Tasmanian Devil (*Sarcophilus harrisii*), and the Tasmanian Wolf or Tiger (*Thylacinus cynocephalus*). There were also odd fragments ascribed to the Marsupial Lion (*Thylacoleo carnifex*) and the Giant Kangaroo (*Palorchestes* sp.), both long since extinct. The Giant Echidna (*Zaglossus hacketti*), Owen's Echidna (*Tachyglossus oweni*) and the Common Echidna (*Tachyglossus aculeatus*) were also unearthed.

Animals found which are still represented in the fauna of today included the Quokka (*Sctouix brachyurus*) which was exceedingly abundant, the Grey Kangaroo (*Macropus ocydromus*), the Brush (*Macropus irma*), the Woilie (*Bettongia penicillata*), the Boodie (*Bettongia lesueur*), the Garlgyte (*Potorous gilberti*), the Possum (*Trichosurus vulpecula*), the Ring-tail (*Pseudocheirus occidentalis*), the Quenda (*Isodon obesulus*), the Dalgite (*Macrotis lagotis*) and the Chuditch (*Dasyurus geoffoii fortis*). Many if not all of these were most probably introduced into the bone-bearing deposits by floods after the stalagmite crust had been breached by the stream flowing through the cave. That they are not truly contemporaneous is indicated by the condition of the bones.

Examined by the crude light of candles years ago it seemed that the bone-bearing deposit was a talus of material that had entered the cave from above and had then been covered with a layer of stalagmite several inches in thickness. More recently, after the installation of electric light, I examined the cave

again and am now of opinion that the bone-bearing deposit is the remnant of a mass of bone breccia which at one time partly filled the large chamber. This remnant was protected by a coating of stalagmite for many years until the protection was undermined by the stream still flowing through the cave and most of the material with its priceless store of animal remains washed away and lost to science. Perhaps at some future time an explorer may find other traces of the breccia which I had overlooked.

The success in the Mammoth Cave aroused interest in the remains preserved in other caves of the area, several of which were submitted to a cursory examination.

The Lake Cave

Excavation was not permitted but a few bones were found including the Grey Kangaroo and the Quokka.

The Museum Cave

Considerable time was spent in this cave with disappointing results though remains of a Tasmanian Wolf were obtained. The list comprises Grey Kangaroo, Brush, Quokka, Boodie, Woilie, Garlgyte, Possum, Ring-tail, Quenda and Tasmanian Wolf.

The Bride's Cave

Grey Kangaroo, Brush, Quokka, Boodie, Woilie, Garlgyte, Possum, Ring-tail, Quenda, Dalgyte and Tasmanian Devil. The skull of the last-named was incredibly fresh and recent-looking, suggesting that the animal had survived in the South-western corner of the State until very recent times.

The Giant's Cave

Grey Kangaroo.

The Golgotha Cave

The only remains noted here were fragments of a skull and mandible of a human being, undoubtedly an Aboriginal.

The Coronation or Moondine Cave

This cave, near Hamelin Bay, was visited one night as the cave guide, Tim Connelly, was of opinion that it contained the complete skeleton of a Dingo lying in a pool at the bottom of the cave. Actually the skeleton was that of a Tasmanian Wolf or Thylacine, complete to the smallest bones. The skull and several bones are now in the Western Australian Museum where they are displayed in the Fossil Room.

The Yanchep Caves

These had been visited many years ago when nothing of importance was reported. However, the opening up of two of these caves as an attraction to tourists brought to light an interesting assemblage which was increased when Professor D. S. Davidson of the University of Pennsylvania undertook some work in the modern method some ten years ago in the Yonderup Cave. In addition to human, Aboriginal, remains, the list included: Grey Kangaroo, Brush, Tammar (*Macropus eugenii*), Garlgyte, Boodie, Woilie, Possum, Ring-tail, Quenda, Chuditch and Tasmanian Devil.

This brief survey of work done whilst showing that much has been revealed suggests that a great deal more may be accomplished by exploring the hundreds of caves yet untouched in the coastal belt of South-western Australia so giving us a more accurate picture of the mammalian fauna of Western Australia in pre-historic times.

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BIOCLIMATIC CONTROLS IN WESTERN AUSTRALIA

By Dr. J. GENTILLI, University of Western Australia, Nedlands

(Continued from p. 84)

EVAPOTRANSPIRATION

Evaporation is by far the least known of all climatic elements. There is a deep disagreement among climatologists even as to the instruments to be used for its measurement. Most work done in the past is based on evaporation from a free water surface, under conditions which are very far from those prevailing in nature. Recent research work conducted in North America principally by C. W. Thornthwaite has led to the measurement of evaporation from soil and transpiration from plants, the two phenomena being combined under the name of evapo-transpiration.

The direct measurement of evapo-transpiration is highly technical, but recently published formulae and graphs permit the estimate of potential evapo-transpiration, which is the amount of water that soils and plants can evaporate and transpire respectively when they have an unlimited supply of water from which to draw. This estimate is of great importance in assessing the movement and loss of water in soils, plants and animals under natural conditions.

The formulae and graphs for the computation of evapo-transpiration were originally published by Thornthwaite in the *Geographical Review* for January, 1948. The computations and drawing of the maps for the present paper were carried out by